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AUTHOR(S):

Iwamoto, Mitsumasa; Yamamoto, Tetsuya; Manaka, Takaaki

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Probing and Analysis of the deformation of two-dimensional domain shape

Dept.of Phys.Elec., Tokyo Inst.of Tech., Mitsumasa Iwamoto [1], Tetsuya Yamamoto and Takaaki Manaka

水面上に形成された単分子膜は、表面圧に応じて様々な相を呈する。そこで、筆者らは誘電物性評価の立場から界面膜の誘電分極構造、すなわち、自発分極、線形非線形分極を、マックスウェル変位電流 ブリュスター角顕微鏡、光第２次高調波により測定する技術開発を進め、その測定に成功した。また、この実験結果を基礎と、界面膜の２次元ドメイン形成に、双極子エネルギーが大きく寄与していることに着目しながら界面のドメイン形状を決定する shape equation の導出もしてきた。本報告では界面膜の分極構造の実験的評価とドメイン形状の理論について紹介し、これらの知見がソフトな材料の新しい物性を見出すのに役立つことを述べる。

On account of symmetry breaking, organic monolayers at the air-water interface show various phases depending on the occupied molecular area. Paying attention to the dielectric polarization phenomena of monolayers, we have been establishing the novel experimental system, which enables us to probe spontaneous polarization, linear and non-linear polarization at the same time. The developed system is a Maxwell displacement current (MDC) and optical second harmonic generation (SHG) detecting instrument that is coupled with a Brewster angle microscope(BAM) [1, 2, 3]. On the basis of experimental results, we have been analyzing the physical properties of monolayers as a soft material, keeping in mind that monolayers possess both liquid crystalline and lattice properties. We will show some of our experiments on liquid crystalline monolayers, and discuss how polarization change is analyzed taking into account the structure change of monolayers in terms of orietational order parameters defined using Legendre polynomials, depending on the monolayer-covering area. Further from the theoretical side, we show how organic monolayer is treated as a two-dimensional system. The dipolar energy of a solid monolayer domain surrounded by fluid phase at air-water interface is derived approximately as a sum of an additionally negative line tension and a curvature elastic energy at the boundary. Variation of the domain energy yields an equilibrium domain shape equation [4]. The obvious solutions of the domain shape equation clearly predict circle, torus, D-form, S-form, and serpentine manner shape found experimentally, depending on the surface pressure, the difference in

[1]E-mail:iwamoto@ome.pe.titech.ac.jp

Gibbs free energy between the solid and fluid phases and the total line tension. The agreement with the BAM observation is shown for Lipid membrane monolayers.

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